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ABSTRACT

Evaluations of the preservice science education program for elementary school teachers at the University of Arizona, Tucson, are discussed. The evaluations of the program are in the areas of course structure and organization, and students' attitudes and overall knowledge of the science processes. (CP)

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FORMATIVE EVALUATION OF ELEMENTARY SCHOOL PRE-SERVICE SCIENCE CURRICULUM

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FORMATIVE EVALUATION OF ELEMENTARY SCHOOL PRE-SERVICE SCIENCE CURRICULUM

The science education program for elementary education majors at The University of Arizona contains two distinct but not separate components. Students are required to complete 12 units of laboratory science courses selected from options generally known as the Science 12 series and also to complete an elementary science methods course. The overall assessment of the Science 12 courses has been done by each of the various science departments within the Liberal Arts College. The elementary science education faculty has additionally assessed the pre-service elementary education student's understandings of and their attitudes towards the processes and the content of science. Changes have been made throughout the sequence to more fully influence the attainment of desireable science education outcomes.

The overall assessments of the Science 12 courses have generally followed similar formats. A description of those assessments and modifications pursued in the Chemistry 12 course and reported and discussed by Boller (1975) and Cassen and Forster (1973) is reflective of most of the entire series. Originally Chemistry 12 consisted of three one-hour lectures plus one three-hour laboratory session per week. This traditional format appeared to be not involving a large proportion of the students and consequently many changes were developed. Student attitudes were considered and a laboratory oriented

course with a self-paced format was devised. The goal was to provide students with as much personalized instruction as possible thus reducing the tension non-scientists experience and consequently inproving competence in science processes.

Several new features were implemented. First of all the laboratory was designed for students working on different experiments at different rates. This feature enabled students to work on experiments until they mastered them or at least were satisfied that their understanding of the subject matter was adequate. Secondly a one student to one teacher testing ratio was established. Students are identified and related to in an understanding way. This forced interaction of student and teachers on a one to one basis helped students relate to the views and perspectives of scientists. Thirdly competency measures were established based on behavioral objectives. Boller (1975) listed the following student benefits from this feature. Firstly, instructors may ask students how they arrived at their answers, an approach which identifies conceptual difficulties and secondly, the printing of the competency measure in the student manual alleviated considerable tension by clarifying what should have been gained from each unit.

Another feature is the non-punitive grading system employed. Students who meet the minimum requirements of the course are guaranteed a grade of C. To obtain the minimum grade, the student must satisfactorily complete a number of specified units

plus a few self chosen additional units. For higher grades, students must complete additional specified and self chosen units. No D or E grades are assigned. Thus grades are used as a motivation factor.

Questionnaires completed by the students immediately after having taked the Chemistry 12 course have served as formative evaluation measures of these innovative features. These questionnaires consistently have revealed that over 80% of the students favor the grading system and that over 90% feel that the competency measures are satisfactory. Additionally over 65% of the students feel that this course should be required for elementary school teachers. The laboratories are viewed as most helpful as is the self paced format. The biggest criticism of the course dealt with the everyday necessity of finding the needed materials. However this is viewed as partially a student responsibility since many students fail to return necessary reagents to their respective places.

Additional information about all the Science 12 courses is collected by the science education faculty during the science methods course which is generally taken approximately two years after completion of the liberal arts science requirements. These attitude questionnaires reveal that students still view the Science 12 courses as worthwhile and meaningful. Physics 12 is found to appeal to fewer students then any of the other courses. Education students also feel that they have an adequate background to teach elementary school science and also

recommend that future elementary education students be required to take the same number of liberal arts science courses. Less than 5% of the pre-service elementary education majors would recommend changing the requirements to include fewer courses. However they also feel other courses could be developed in some other science disciplines, mainly plant sciences or ecology. Elementary science education faculty members have found most of the students well based in scientific facts and processes. This has allowed them to stress more alternatives in teaching methods and more fully deal with methods emphasizing hands on activities and integration of both science concepts and processes. Student awareness of materials available for elementary school children has also led to a de-emphasis of science education modules dealing with science materials and resources.

During the elementary pre-service education courses several additional formative assessments have been made that have influenced the science methods course content and structure. Two of these have dealt with comparison of teaching attitudes among the various block programs, two have dealt with the interaction of cognitive styles and teaching methods, and one has dealt with overall knowledge of the science processes and its relationship to student achievement in the science methods course. Instruments used in these formative assessments have included a science process instrument similar to that reported by Welch and Pella (1968), a science teaching affective attitude instrument similar to that reported by Good (1971), the PMT

Questionnaire (Wiggins, 1973), the James Internal-External Scale (James, 1957), and the Group Embedded Figures Test (Witkin, 1971).

As a total group, initial understanding of the processes of science has been found to be significantly correlated to grades received in the elementary science methods course. Modules are included that deal with the processes of science and their usefulness for selecting science activities, evaluating student progress, and analyzing children's behavior. Some of this information is evidently not new to students who have completed their science requirements from the Science 12 options. The knowledge students previously acquire about the science processes greatly enhances their success in the methods courses. The ability to apply the processes of science to educational settings evidently depends upon prior understanding and utilization of the science processes in the Science 12 laboratory settings. Thus the Science 12 series is viewed as very meaningful for students. If all students were as familiar with the processes as they apply to science, less time could be spent on defining and identifying these processes. At the present, however, many students still transfer in their science requirements, thus necessitating more science methods class time spent on reviewing and integrating the science skills into the elementary curriculum than might be needed.

Comparisons among the different block structures assessed attitudes about teaching science and about general aspects of elementary school teaching. On an affective instrument dealing

with opinions about teacher and student structure, students in the Open Block format consistently ranked items about student structure higher than did the other block programs. They felt more secure as a group about letting students work with equipment and determining their own objectives. Thus introduction to the ESS program was found most effective with this group of students. Other groups preferred more structured approaches feeling it is the teacher's responsibility to help students practice certain kinds of science skills and activities for better understanding. Students in the early childhood block were also more concerned about selecting appropriate activities with the science materials than students in the other block programs. There was little pre-test post-test changes in science teaching attitudes in any of the block programs. Consequently it is felt that after introduction to the various elementary science curriculums, students in the open block can be most effectively taught to use ESS materials and a discovery method, while other block students may more effectively utilize S:APA II, SCIS, or textbook oriented unit programs. Guided discovery and rational inquiry models of instruction seem to be the most useful for the early childhood and on campus students, while the students in the self-contained block appear to most effectively use total unit instruction based on textbook selected conceptual schemes. These approaches are most similar to the philosophical beliefs of the different groups of students and thus will probably be the ones that are most effective for each group.

Horak, Roubinek, and Bevil (1977) have previously reported findings related to the PMT Questionnaire and the block programs at The University of Arizona. These findings have revealed the need for extension of the alternative programs. Educational beliefs are apparently not changed dramatically by one year programs. However pre-service students may be introduced to science teaching models that more accurately reflect their views. These views have led to the reorganization of the structure of some of the block programs and to the inclusion of modules selected specifically for each of the various blocks and dealing with topics such as textbook evaluation, psychological development and the science curriculum, science classroom management, and evaluation procedures.

Two additional studies have dealt with student's cognitive styles and have led to changes in the format of the elementary science methods course. One study (Horak and Slobodzian, 1978) assessed elementary student's locus of control and their science achievement on a process and content measure dealing with application of the science processes to prescribed field trip experiences. This experimental study assessed the effects of high structured and low structured instruction in the science methods course. The students enrolled in the methods course were found to be more external than the population in general. Additionally while a high structure method was most useful for all students learning to apply science process to children's experiences, a disordinal aptitude-treatment-interaction was found between teaching method and an application measure of content. Thus more structure has been added to the science

education units which deal with involved science content while structure is varied for many of the hands-on activities in which the pre-service students engage.

A similar study (Horak, 1977) investigated inductive-deductive teaching styles and their relationship to achievement on a transformational geometry unit. This study utilized the Group Embedded Figures Test to measure field dependence-independence in a population of elementary pre-service teachers at the University of Arizona. Pre-service elementary education majors were found to be slightly more field-dependent than the population in general. Additionally all the students did better on the transfer subtest and the analysis subtest with the inductive teaching method. This teaching method was structured but employed an example rule paradigm. The more field independent students-those who scored 5 or below on the GEFT- also did better on the overall achievement test under the inductive method.

The preceding assessments are viewed as formative by the elementary science education faculty. Course content and teaching methods are changed to meet the needs of the majority of the students. Thus the liberal arts component and the elementary science methods course component are presently designed in varying formats and constantly under re-evaluation.

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